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EU Accession of Central and Eastern Europe

Bridging the Income Gap

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The countries of Central and Eastern Europe (CEE) have much to gain from implementing policies that increase investment, support the development of human capital, and promote the legal, regulatory, and policy framework needed for market mechanisms to function. The faster they implement such changes, the faster they will bridge the income gap between them and the countries of the European Union — and the more likely their chances of successful integration.

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Summary findings

Joining the European Union (EU) is perhaps *the* key political and economic objective of Central and Eastern European (CEE) countries as they approach the 21st century.

But how successful the CEE countries are in achieving this goal depends not only on how well and quickly they adapt their legal and regulatory systems to EU requirements but on how well and quickly they bridge the wide income gaps between CEE and EU countries.

Using a model and cross-section data to develop estimates, Barbone and Zalduendo investigate how "appropriate" structural policies adopted before and after accession to the EU can help CEE countries bridge this income gap.

They have much to gain from implementing policies that increase investment, support the development of human capital, and promote the legal, regulatory, and policy framework needed for market mechanisms to function.

The faster they implement such changes, the faster they will bridge the income gap between them and the EU countries — and the more likely their accession to the EU will be successful.

This paper — a product of Country Department II, Europe & Central Asia — is part of a larger effort in the Department to examine issues related to accession to EU by Central and Eastern European countries. Copies of this paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433-0001. Please contact Luca Barbone, room H11-079, telephone 202-473-2556, fax 202-477-1034, internet address lbarbone@worldbank.org. February 1997. (42 pages)

EU ACCESSION OF CENTRAL AND EASTERN EUROPE

BRIDGING THE INCOME GAP

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I. Introduction

This paper is motivated by the consensus view that the accession to the European Union (EU) of Central and Eastern European (CEE) countries will heavily influence the policies they implement and that, in turn, this might have important consequences for economic growth. The accession process is realistically expected to take several years, but the ties with the European Union are likely to grow increasingly stronger in a number of crucial areas ranging from institutional and political coordination to resource flows.

Key among the many aspects related to EU accession is the per capita income gap that exists between even the most developed CEEs and the present EU member countries. As Table 1 highlights, CEE countries are very far from the EU average income per capita level[1]. This gap is likely to affect the EU-CEE accession negotiations, and its gradual bridging is a necessary condition for a sustainable single market, particularly with regard to labor mobility. This will in turn require that the average growth rate in CEE countries be higher (substantially higher) than the EU average.

The growth literature suggests that countries which have similar "environments" converge in incomes per capita. However, what is relevant for the population of CEE countries is not only the expectation of convergence taking place but, more importantly, that such convergence occurs as rapidly as feasible. Rapid convergence is also important from the perspective of current EU members. If the European Community is to financially support the reduction in income disparities between present and future members, then an estimate regarding the time frame for this convergence to occur might be extremely helpful for financial and budgetary planning purposes. Moreover, identifying the forces that enhance convergence may have a catalytic role in defining the policy requirements for EU accession.

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[1] The GNP per capita estimates in purchasing power parity terms (PPP) show that CEE countries are closer to the EU average than if we use current exchange rate GDP per capita data.

Table 1: Evolution of GNP per Capita (in US$) for a Selected Group of CEE Countries.

	GNP Data Based on WB Atlas Methodology 1990		1992		1994		GNP-PPP Estimate 1994	
	Level	Share of EU Average	Level	Share of EU Average	Level	Share of EU Average	Level	Share of EU Average
Czech	3490	22	2570	14	3200	17	8900	53
Hungary	2910	18	3120	17	3840	20	6080	36
Poland	1700	11	1950	11	2410	13	5480	33
Slovakia	3330	21	2250	12	2470	13	6450	38
Slovenia	9500	59	6770	37	7020	37	6230	37
EU Average	16185		18532		19005		16757	

Source: The GNP data for 1994 in PPP terms is from the 1996 World Development Report.

Considerable thinking has gone into the elaboration of policy agendas that would allow sustained medium-term growth. Not surprisingly, given the relative similarity of initial structural conditions, the prescriptions for most CEE countries have been fairly similar. They include (i) strengthening property rights and the administration of government services, including the adequacy of general legal provisions to functioning of market mechanisms (from bankruptcy laws to collateral legislation); (ii) completing the privatization agenda; (iii) strengthening banking regulation and supervision to support the development of capital markets, crucial for the continued development of private sector activities; (iv) controlling the size of the state (particularly on the social spending front) and eliminating disincentives against labor in the tax system; and (v) opening these economies to the flow (both inward as well as outward) of goods and services to enable a more efficient allocation of resources. Although these policy agendas (both those implemented as well as those that are still pending) are widely accepted as conducive to high economic growth rates, little has been done to examine their growth implications. The aim of this paper, therefore, is to derive lessons from the economic literature that may help to link these structural reforms with the growth prospects of CEE countries.

We develop a model to examine the issue of bridging of income gaps and derive some lessons for the EU accession of Central and Eastern European countries. This paper is organized as follows. We begin by presenting a background discussion on alternative concepts of convergence and the key features of the neoclassical growth literature. The model is then briefly described, highlighting in particular the importance of the underlying policy framework in determining economic growth. The following section discusses our empirical results[2]. Section V presents some convergence and growth exercises, with special emphasis on the implications of different policy and non-policy scenarios. We conclude by discussing the main policy implications that can be derived for CEE countries and their accession quest. This paper will build on the findings of the recent econometric studies of the growth literature (e.g., Barro, 1991) and on the convergence discussions for CEE countries initiated by Sachs and Warner (1996).

II. Convergence of Incomes across Countries

First, some definitions. In neoclassical growth models a country's per capita growth rate is inversely related to its starting level of per capita income. This is known in the growth literature as the *absolute convergence* hypothesis, which hinges on the existence of diminishing returns to reproducible capital: *given sufficient time all countries should converge to similar per capita incomes*[3]. The hypothesis of absolute convergence implies that rich countries should grow at a slower rate than poor countries. However, this is not consistent with cross-country data. As shown in Figure 1, the growth rates per capita (defined in this paper in terms of persons in the labor force) show little correlation with the starting levels of GDP per capita in a sample of over 80 countries for the period 1965-89. Other authors, working with different data sets, have also identified similar patterns (see, for example, Barro, 1991). This contrast between the empirical evidence and the

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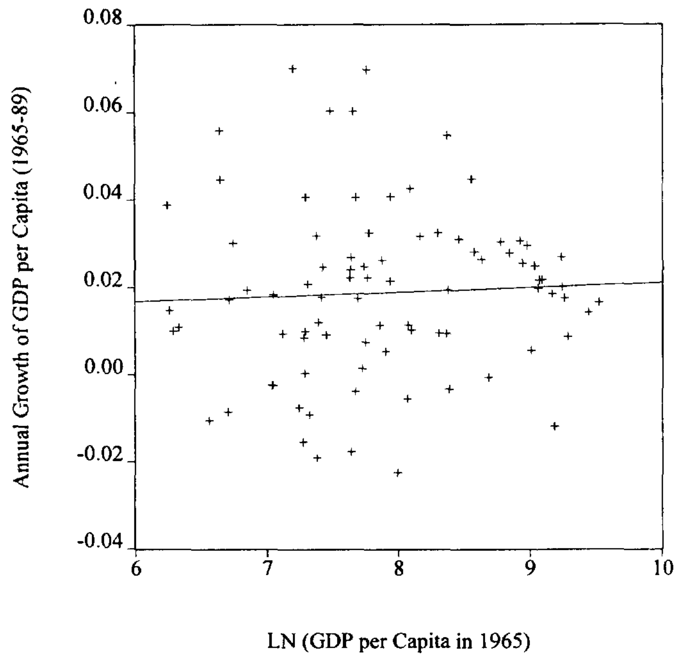
2 The more formal presentation of the model is found in Appendix 1 and is followed in Appendix 2 by a thorough discussion of the estimation results.

3 Some growth models treat savings as exogenous (e.g., Solow, 1956) while others have aimed at endogeneizing the savings decision process by introducing an optimizing representative consumer. The latter group is best represented by Ramsey (1928), Caas (1965), and Koopmans (1965). As Erhlich (1990) has highlighted, the growth literature entered in the late 1960s into a dormant phase which was interrupted by the papers of Romer (1986) and Lucas (1988). The so-called "new growth literature" is mostly directed to providing an interpretation for long-run economic growth which is not based on the exogenous technological progress explanation.

theoretical prediction of the neoclassical growth model has been one of the main objections raised against this literature[4].

Figure 1: Lack of Absolute Convergence.



Notes: This figure graphs the average annual growth rate between 1965 and 1989 against the natural logarithm of the initial level of GDP per capita. If the theoretical prediction of absolute convergence was accurate, we should observe a downward trend. The countries included in this figure are those on which the estimations in this paper are based (see list in Appendix 3).

Lack of absolute convergence in per capita incomes among countries may be attributed to their diverse initial conditions, which are also referred to as differences in *environment factors*. These include factors that are non-renewable or not changeable, such as resource endowments and geographical location of a country (also referred as fixed factors), and those that are variable and, in principle, can be affected by government policy. These differences imply that countries will have

4 The other main criticism it has received relates to the fact that growth in per capita terms occurs only as a result of exogenously determined technological progress, thus providing an extremely uninteresting theory of long-run economic growth.

growth rates of GDP determined by their own environments. If we net out from the growth rates of GDP of any group of countries what can be attributed to these differences in environment (i.e., among other, differences in human capital, government policies, consumer preferences, and other growth determinants), then it has been argued that the hypothesis of poor countries growing more rapidly than rich countries is once again true. This is known as *conditional convergence* (see Box 1 for a more thorough discussion)[5].

Box 1: Different Concepts of Convergence.

The augmented neoclassical growth model assumes an aggregate production function in which physical capital, human capital and labor are the only three inputs and where technological progress is assumed to be exogenously determined. This model also assumes that the production function exhibits diminishing returns to each individual input. The latter implies that, assuming two of the three inputs are fixed, the first units of the non-fixed input enable to produce more units of output than the following units of that same input.

In this framework, if countries ARE EQUAL in all respects except for their initial level of capital per capita (both physical as well as human), then poor countries (i.e., those with less capital per capita) get more out of each extra unit of capital per capita than rich countries. Hence, poor countries grow more rapidly than rich countries and, eventually, the output per capita of each country is equal. Thus, it is said that ***absolute convergence*** takes place because these countries reach the same capital per capita (of both types) and output per capita level. This level is known as the steady state and, in the neoclassical growth model, implies no growth takes place in per capita terms when assuming no technological progress.

However, this concept of convergence seems to have little relation with the existing evidence for different groups of countries. This is mainly because countries ARE NOT EQUAL and differ in many aspects which are relevant for economic growth. For example, it may well be the case that two countries have different savings rates, different rates of population growth, different government policies, different consumer tastes, or different production technologies. These differences are precisely what determine the lack of a clear trend in **Figure 1** and imply that each country has a different steady state level. In this context, the concept of ***conditional convergence*** suggests that the country that finds itself proportionately farther away from its OWN steady state will grow faster than the country that is proportionately closer to its OWN steady state. This enables, for example, rich countries with very high savings rates to grow faster than poor countries with very low savings rates.

The evidence on convergence among current members of the European Community suggests that the countries in CEE (and their regions) might converge, in time, to the EU average income per capita level. This seems to be also supported by the experience of some late-comers into EU membership. For example, with the exception of the slowdown observed in recent years, Greece, Ireland, Portugal, and Spain have seen a significant decrease in their own gaps with the EU average (see Table 2). As the regional convergence studies of Barro and Sala-i-Martin (1995) have shown, convergence does occur whenever the environments are similar. The CEE countries should

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[5] In this paper we do not examine the implications of fixed factors and center the analysis on those which are variable. For an analysis that evaluates natural resources and geographical location see Sachs and Warner (1995).

then expect income convergence to take place as they implement policies in tune with EU accession requirements. However, it is also the case that convergence is slow. As shown in Table 2, the four poorest current EU member countries have reduced only by approximately one-half their initial difference with the EU average income per capita during the last 34 years.

Table 2: Evolution of GDP per Capita (in US$) among EU Member Countries.

	Summers and Heston Data - Mark 5.6								**GNP-PPP Estimate**	
	1960		**1970**		**1980**		**1990**		**1994**	
	Level		Level		Level		Level		Level	
EU High	8530	Sweden	12018	Sweden	13809	Sweden	16106	Sweden	20270	Belgium
EU Average	5700		8484		10793		13168		16757	
EU Low	2188	Portugal	3853	Portugal	5723	Portugal	7565	Greece	10930	Greece
	Level	Share of EU Average	Level	Share of EU Average	Level	Share of EU Average	Level	Share of EU Average	Level	Share of EU Average
Greece	2414	42	4824	57	6662	62	7565	57	10930	65
Ireland	3918	69	5939	70	8056	75	10837	82	13550	81
Portugal	2188	38	3853	45	5723	53	8487	64	11970	71
Spain	3620	64	6813	80	8521	79	10802	82	13740	82

Note: The EU Average is an unweighted mean of all current EU members.

Source: The GNP data for 1994 in PPP terms is from the 1996 World Development Report.

III. The Model

• *Can we make reasonable guesses as to the time it will take CEE countries to converge to a certain threshold; say, for example, 75 percent of the EU average income per capita level?*

• *To what degree can government policy influence the time frame during which income gaps are bridged?*

• *What is the impact of different policy scenarios for an economy's average long-run growth rates?*

To answer these questions we develop and estimate a growth model for a large cross-section of countries, and we then apply the results to CEE countries. Following the above discussion on conditional and absolute convergence, we recognize that significant differences exist between CEE and EU countries and that, therefore, a model based solely on the concept of absolute convergence would inadequately address the bridging of income gaps between CEE countries and the European Community. Hence, the model presented in this section will allow for differences in environments among countries, thus implying an analysis based on the concept of conditional convergence.

Box 2: Data Used in the Econometric Estimation.

To estimate our growth equation we use cross-section data from the version Mark 5.6 of the Penn World Tables compiled by Summers and Heston (1991). This data is based on the United Nations International Comparison Project which aims at providing comparable national accounts information by using detailed price comparisons for over one-hundred products. The prices are then used to convert local currency country data into a common currency unit, therefore enabling real quantity comparisons across countries. This data is available from the NBER web site.

From this database we use the GDP per capita for the years 1960, 1965, and 1989, defined as persons in the labor force (i.e., the economically active population), and the share of GDP assigned to investment in physical capital, calculated as the annual average share for the period between 1960 and 1989. The rate of growth of the labor force is the average corresponding to the period between 1960 and 1989 and is calculated from the annual data on population and GDP per capita for that period, the latter both in terms of persons in the labor force as well as in terms of total population. We assume that the rate of technological progress and the depreciation rate are the same for each country, the sum of which is set equal to five percent a year. Setting the sum of technological progress and depreciation rate at 5 percent is in line with other studies, such as Mankiw, Romer, and Weil (1992) and King and Rebelo (1990). The data on human capital is based on the educational attainment level calculated by Barro and Lee (1993). Of the data they have compiled we use the mean for three years --1975, 1980, and 1985-- of the average number of years of education of the total population.

We assume that output in any country i is produced according to the following production function

$$Y_i = K_i^{\alpha} \; H_i^{\beta} \; (A\,N)_i^{1-\alpha-\beta} \quad . \qquad [1]$$

In this equation Y is output (GDP), K represents physical capital, H is human capital, A denotes the country's level of technology, and N is the number of persons in the labor force[6]. Both α and

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[6] The introduction of human capital into a production function with constant returns to scale is similar to viewing capital as a broadly defined input (i.e., one which includes both human as well as physical capital). This has also been referred by many authors as a Solow-augmented model (see, among others, Barro and Sala-i-Martin, 1995, and Mankiw, Romer, and Weil, 1992). While a model based on this production function would still imply that long-run economic growth is exogenously determined, our aim is to analyze (conditional) convergence. Endogenous growth models have little to say on this topic since their main goal is to provide an interpretation as to why countries continue to grow indefinitely without relying on the exogenously given technological progress explanation. In this sense, convergence is not the usual focus of these models.

β are between zero and one and represent, respectively, the share of each capital type in total output. The sum of these two parameters is strictly less than unity and technological progress is assumed to be labor-augmenting.

Physical capital and human capital are assumed to accumulate in similar fashion. The dynamic equation for physical capital is given by

$$\dot{K} = s_k Y - \partial K \qquad [2]$$

where $\dot{K}$ is the change of the physical capital stock at any point in time, s_k is the share of output dedicated to the accumulation of this type of capital and ∂ is its depreciation rate. Similarly, human capital accumulates according to

$$\dot{H} = s_h Y - \partial H \qquad [3]$$

where $\dot{H}$ is the change of the human capital stock at any point in time, s_h is the share of output assigned to the accumulation of this input and the rest of the notation follows the definitions already presented. For simplicity we assume the same rate of depreciation for physical and human capital.

As discussed in Box 2, we use as the share of GDP assigned to the accumulation of physical capital the data on gross domestic investment in the economy as a percentage of GDP. For the share of GDP allocated to the accumulation of human capital we will use as a proxy the average level of this input in the economy. We also assume that the policy framework (i.e., the existing economic policy, regulatory, and legal features of the economy) is essential in determining the effectiveness of human capital in the production process. As one example, the economic performance in recent decades of the formerly centrally planned economies of CEE is a good representation of why high levels of human capital, or of investment in this input, do not in themselves ensure long-term growth. This approach is also consistent with the results of empirical studies which introduce policy indicators as explanatory variables in growth equations (see Barro, 1991, and Sachs and Warner, 1996). More specifically, we define investment in human capital as

$$s_h = \gamma \, h \, Z^{\phi} \qquad [4]$$

where γ is a proportionality factor which will be embodied in the constant of the equation we estimate and h is the stock of human capital in effective labor units (i.e., the number of human capital units per person scaled by the economy's technology level). The variable Z is an index that represents the policy framework of the economy and is limited to the closed interval [1,5]. The parameter ϕ has no special restrictions beyond being strictly positive.

We can write the model represented by equation [1] through [3] in its intensive form (i.e., in per capita terms rather than total terms)[7]. Log-linearizing the derived growth equation, solving for the steady state, and using equation [4] (see Appendix 1 for the full derivation), we may write the growth equation to be estimated (see Appendix 2 for a more thorough discussion) as

$$GR = \chi_0 + \chi_1 \ln y(0) + \chi_2 \ln s_k + \chi_3 \ln h + \chi_4 \ln Z - (\chi_2 + \chi_3) \ln(\partial + n + a) + \varepsilon \qquad [5]$$

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7 We define the growth rate of output as $GR = (\ln \hat{y}(t) - \ln \hat{y}(0))/t$ where $\hat{y}$ is the level of output per capita, net of the level of technology in the economy, and t is the number of years. Also, notice that we have assumed that the index of policies Z affects only human capital and not physical capital (see equation [4]). Recognizing that this might be interpreted as a drawback of the model, we wish to make a few comments in defense of our assumption. First, our reasoning is that the index Z affects the effectiveness of "stocks" of inputs. This allows to argue that as the index Z has become higher in CEE countries, the "existing" stocks of inputs have become more productive. Second, human capital should be thought to represent not only the quality of the labor force, but the entrepreneurial ability of firm managers and/or owners. As a result, a high value for the index Z enables a more efficient "production process", but the intrinsic capabilities of the existing stocks of inputs are still constant. Thus, ceteris paribus, a machine designed to produce 10 screws per time period is still capable of producing 10 screws. If it accomplishes or not the production capacity for which it was "designed" will depend on factors which are exogenous to the machine capabilities. Finally, the reader should also acknowledge that we are bound by the theoretical foundation of our model. If we opted for assuming that the index Z also affects physical capital, we must first find a way to introduce such restriction. However, the resulting growth equation would still result in an equation similar to [5]. The sole difference would reside with the interpretation of the coefficients χ_0 and χ_4 being estimated. Alternatively, we would need data on the stock of physical capital which has its own added difficulty due to its limited availability and poor quality. In sum, our belief that we should only "penalize" the stocks of inputs, the interpretation of human capital as a broadly defined input (i.e., which also includes entrepreneurial ability), and the fact that the implications for the growth equation are mostly inconsequential, lead us to maintain our assumption that the index Z affects only the effectiveness of human capital. While we acknowledge that their might still be room for disagreement as to the merits of this assumption, we wish to conclude by stating that the apparent asymmetry in our treatment of physical and human capital may be also viewed as the result of the intrinsic complementarity between these two inputs.

where the different coefficients χ_0, χ_1, χ_2, χ_3, and χ_4 are non-linear functions of the parameters of the model and GR is the average annual long-run growth rate.

An obvious difficulty in estimating equation [5] is how to define Z, which is assumed to represent the policy framework of an economy (i.e., a broadly defined economic policy, regulatory, and legal framework of the economy). Our priors suggest that it should include, among other variables, indicators of monetary policy, fiscal policy, degree of openness, rule of law, and degree of price system distortion. The Index of Economic Freedom (IEF) constructed by Johnson and Sheehy (1996) contains these indicators. There are a total of ten variables in the IEF which could be grouped by pairs into the five mentioned indicator types. The variables related to monetary/banking policy are the annual average inflation rate between 1985-93 and the existence, or not, of restrictions to opening banks (with emphasis on restrictions for foreigners). The data on fiscal policy are based on a measure of the tax burden and the size of government consumption, both measured as a share of GDP. The indicators on price system distortion relate to the existence of price and wage controls and an estimate of the size of black market activities. The concept of rule of law defines the presence of corruption practices in the administration of government services and the significance, or lack of, regulatory frameworks (e.g., simplicity of licensing procedures). Finally, the measure of openness of an economy is assessed according to the average level of tariffs and the restrictions on capital flows and foreign investment. From all these indicators an average is constructed which we then use in our regression estimates[8].

Although the IEF constitutes an interesting aggregation of the policy, regulatory, and legal framework in which economic activities take place, the use of the IEF index is not without its own difficulties. Two limitations of this index need to be highlighted. First, the IEF index has been calculated for recent years and, therefore, is incapable of representing accurately the economic policy and legal framework for the complete period of study (i.e., the growth rates between 1965-89). This has already been noted by Sachs and Warner (1996). A more ambitious

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[8] The IEF index has already been used in the past by Sachs and Warner (1996). However, our use of the index is in the context of a theoretical model where the structural framework represented by the IEF is assumed to play an important role in determining the effectiveness of human capital in the production process.

endeavor would be to construct an index Z which would incorporate the benefits of more "time series information", a task which we partially pursue with a modification we introduce into the IEF index (see Box 3). Second, we believe the index is at times too loosely and subjectively defined, thus becoming prone to arbitrary measurement errors of uncertain distribution. In working with this index we assume the authors were closely involved in the assignment of values for each country. However, we would feel more at ease if the index could be put together with a higher degree of reliance, when possible, on quantifiable information. Notwithstanding the above, we find its emphasis on the policy, regulatory and legal framework of an economy (i.e., monetary policy, fiscal policy, rule of law, price system distortion, and degree of openness) well founded and aimed in the right direction.

Box 3: Methodology Used to Construct the Modified IEF Index.

We modify twenty percent of the index constructed by Johnson and Sheehy (1996) by replacing the two components that relate to the degree of openness of the economy (i.e., trade and capital flows). The original IEF index emphasizes only the consequences of tariffs to evaluate the openness to international trade. We will replace this by considering not only the average level of tariffs, but also the share of industrial output affected by quantitative restrictions. Also, the original IEF evaluates a country's openness to capital flows by examining the degree to which each country interferes or not with foreign direct investment. This evaluation is mostly based on conclusions derived from an analysis of the legal and regulatory framework of the country. We assume a more market oriented, albeit still limited, methodology to measure capital movements by centering only on the existence of premiums in exchange rates as represented by the difference between the market and official exchange rate. Thus, our degree of openness of the economy has three components (i.e., tariffs, QRs, and exchange rate premiums), each with a weight of one third in the final index representing the degree of openness of the economy, and the period under study corresponds to the 1970s and 1980s. Several sources are used, among them Sachs and Warner (1995) and the IMF's International Financial Statistics. The main advantage of this modified IEF index is that it contains more "time series information" than the original series compiled by Johnson and Sheehy.

To construct the index, a value in the range 1 to 5 is assigned to each of the three indicators of openness previously mentioned and a weighted average of the mean of these three indexes and the remaining eighty percent of the IEF index is calculated. The table in this box represents how the index values were assigned for an economy's degree of openness. To summarize, the countries with a value between the mean and the median for each of the three indicators is assigned an index value of 3. Those countries with indicator values between zero and half the distance to the median (which happens to be the smallest between the latter and the mean) are assigned a value of 5. From there to the median a value of 4 is given to the complying countries. The value of 2 is assigned to countries that are in between the mean value and the upper bound reported in the table below. The index value of one is reserved to those countries which register the worst openness indicators.

Intervals Used to Assign Index Values to Openness Indicators.

Value Assigned	Average Share of Tariffs	Average Share of Industrial Output Subject to QRs	Premiums in the Exchange Rate Market
5	$x < 0.065$	$x < 0.04$	$x \leq 0.05$
4	$0.065 \leq x < 0.13$	$0.04 \leq x < 0.1$	$0.05 \leq x < 0.1$
3	$0.13 \leq x < 0.17$	$0.1 \leq x < 0.21$	$0.1 \leq x < 0.25$
2	$0.17 \leq x < 0.7$	$0.21 \leq x < 0.5$	$0.25 \leq x < 0.5$
1	$0.7 \leq x$	$0.5 \leq x$	$0.5 \leq x$
Minimum Value	0.000	0.000	0.000
Median	0.133	0.103	0.115
Mean	0.174	0.214	0.426
Maximum Value	1.319	0.888	8.015

IV. Estimation Results

The goal of our econometric estimation is to gauge how much of the growth rate of a cross-section of countries might be explained by the initial level of GDP per capita (i.e., pure and simple absolute convergence) and, since we allow for diverse environments across countries, by the share of investment in physical capital, the stock of human capital, the policy framework within which economic activities take place (i.e., the IEF index previously discussed), and the rate of growth of the labor force. In effect, these *environment factors* determine different steady state levels for each country and will be referred in the rest of this paper as *growth determinants.* To achieve this goal we regress the annual average growth rates of per capita GDP (in PPP terms) on the four growth determinants mentioned above and the initial level of output per capita. The econometric estimation follows the specification described in equation [5][9]. In Appendix 3 we present the list of countries included in each regression and the corresponding data[10]. The period under study is in all cases 1965-89.

In Table 3 we present the average values of our five coefficient estimates (i.e., χ_0, χ_1, χ_2, χ_3, and χ_4). From these estimates we derive the implied values of φ, α, β and ϕ using, respectively, equation [viii] and equation [xi] of Appendix 1 and Appendix 2. Recall that α and β are the shares of both capital types in total output and ϕ is a parameter that affects the policy framework of the economy[11]. Also, from Appendix 1 we know that φ is the speed with which a

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9 A total of eight different regressions are estimated in this paper, half of which are based on the original IEF index while the other half use the modified IEF index discussed in Box 3. A thorough discussion of the estimation procedure is presented in Appendix 2 of this paper.

10 We begun with a total sample of 100 countries. However, as can be observed in Appendix 3, this number got reduced to slightly over 80 since some data was not available for our original sample, particularly that on the level of educational attainment. Note that CEE countries have been excluded from the econometric estimation. Also, we modify in all regressions the data from Johnson and Sheehy by inverting the index ordering so that higher numbers --the range is from 1 to 5-- indicate less government intervention or a higher degree of economic freedom. The goal of this modification is to make this index consistent with equation [4].

11 Note that the sum of α and β in Table 3 leads to a share of capital, in its two types, equal to approximately 60 percent of total output. This is consistent with the finding that high shares of capital are required to explain slower speeds of convergence in neoclassical growth models. In this respect, the usual shares of capital of close to 30-40

country converges from its current per capita level to its own steady state level (i.e., the level at which growth of output per capita ceases)[12].

Table 3: Coefficient Estimates and Implied Values.

	χ_0	χ_1	χ_2	χ_3	χ_4
Coefficient Estimates	0.08787	- 0.01895	0.01697	0.00976	0.02504
Standard Errors	0.018	0.003	0.004	0.004	0.008
T-Statistic	4.72	-6.39	3.98	2.48	2.99
Adjusted R Squared		0.491			
Standard Error of Regression		0.014			
F-Statistic		21.34			
	φ	α	β	ϕ	
Implied Values	0.02527	0.37158	0.21361	2.56559	

• *What are the main conclusions one may derive from the estimation results?*

As shown in Figure 2, using the estimation results we can now show that there is an inverse relationship between the initial level of GDP per capita and the *net* growth rate of GDP per capita. Thus, the hypothesis of convergence holds if we first subtract from the growth rates what may be explained by a country's *own* environment factors (i.e., the mentioned growth determinants). In sum, the theoretical prediction of decreasing returns to reproducible capital is rescued through the interpretation of conditional convergence[13].

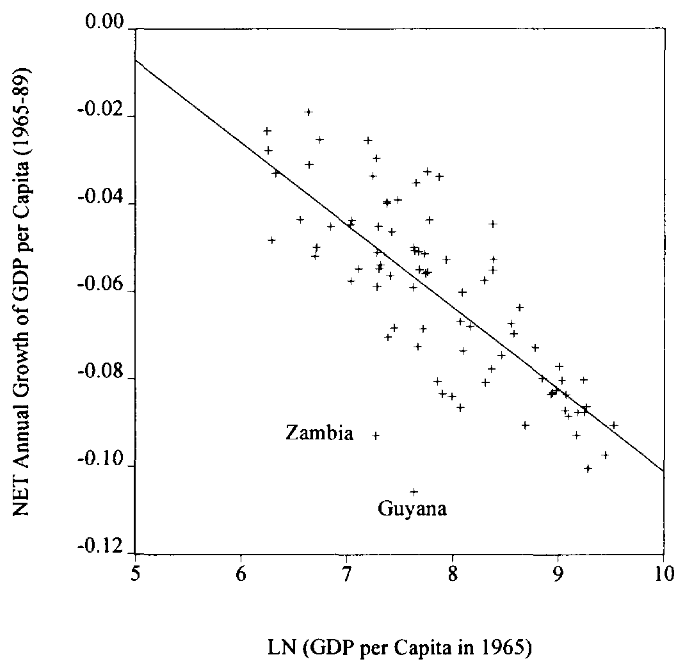
percent were shown to be insufficient to explain slow convergence processes (for a discussion on this topic see, among others, Barro and Sala-i-Martin, 1995).

12 We assume our estimates adopt the values corresponding to a restricted two-stage least square estimation that uses the modified IEF index; that is the last column of Table A-2 in Appendix 2. Other estimation results and a more thorough discussion are also presented in this appendix.

13 Figure 2 also reports the observations for Guyana and Zambia which are evidently off the trend of all other countries. We opted for keeping both of them in our estimations, though this implies on average a reduction of the coefficient of multiple determination from approximately 0.6 to 0.5 (i.e., our equation explains 50 percent of the

Also, the speed of convergence φ is estimated in our regressions at approximately 0.0248. That is, each year there is a reduction equivalent to approximately 2.5 percentage points in a country's own income per capita gap (i.e., the difference between the initial income per capita of a country and its own steady state level). As shown in Table 4, our estimate for φ falls in between those of other authors and implies that reducing in one-half a country's own income per capita gap will take approximately 28 years.

Figure 2: Presence of Conditional Convergence.



Notes: This figure graphs the average growth rate between 1965 and 1989, NET of the value predicted by all explanatory variables other than the natural logarithm of the initial level of GDP per capita, against this initial GDP per capita. The countries included in this figure are those on which the estimations in this paper are based.

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observed growth rates if we include Guyana and Zambia and over 60 percent if we exclude them). Future research will aim at excluding these two countries from our estimation. Nonetheless, it is worth highlighting that the coefficient of multiple determination when we include these countries is still among the highest that have been reported in growth equations for a cross-section of countries.

Table 4: Speed of Convergence Coefficients.

	Barro and Lee.	Barro and Sala-i-Martin.	Mankiw, Romer, and Weil.	Sachs and Warner.	Barbone and Zalduendo.
Value of φ	0.0286	0.0302	0.0178	0.0168	0.0248
Years required to reduce in fifty percent a country's own gap between the initial level and the initial steady state level of GDP per capita:					
	24 years	23 years	39 years	41 years	28 years

The implications of each of the other coefficient estimates are also extremely interesting and are summarized in Table 5. For example, increasing by 2.5 percentage points the share of investment in GDP will lead to an increase of approximately one fourth of one percent in the annual growth rate. Similarly, increasing by one year the average number of years of education of the adult population implies an increase of close to 0.1 of a percentage point in the annual growth rate. An increase in the index that represents the economy's policy framework (i.e., the original or the modified IEF Index) by one half of a point --say from 4 to 4.5-- results in an increase of the average annual growth rate of approximately 0.2 of a percentage point. Finally, increasing the fertility rates (i.e., $a + n + \partial$) by 0.002, say from 0.054 to 0.056, leads to a reduction in the growth rate of approximately 0.1 of a percentage point a year. Thus, increasing the labor force size leads to a reduction of the per capita growth rate since it lowers the per capita levels of each input. As expected, the implications of our growth determinants (i.e., the signs of our coefficient estimates) are the appropriate ones. Also, notice that these variations in growth rates are very significant when compounded over long periods of time. For example, growing at two extra percentage points a year allows output per capita to increase by slightly more than 80 percent during a thirty year period[14].

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[14] By the term fertility we are referring to those factors that lead to variations in the labor force size. While it may well reflect the country's own mortality and natality rates, it is also related to other factors such as the evolution of the share in labor force participation of different gender groups and the country's own cultural background and degree of development.

Table 5: Coefficient Estimates and Implications for Economic Growth Rates.

	Change in the Value of Growth Determinants		Change in Annual Growth Rates
Investment as a Share of GDP:	+ 2.5 percentage points	IMPLIES	+ 0.25 percent growth.
Human Capital:	+ 1 year of adult education	IMPLIES	+ 0.10 percent growth.
Policy Framework:	+ 0.5 in the Index Z	IMPLIES	+ 0.20 percent growth.
Labor Force Growth Rate:	+ 0.02 percentage points	IMPLIES	- 0.10 percent growth.

V. Convergence and Growth: What Lies Ahead for CEE Countries?

We have estimated a theoretical model using cross-section data. As previously mentioned, we have allowed for the existence of differences across countries which go beyond different initial levels of output per capita. Thus, the performance of a country also depends on its own *environment factors* or, as we have also called them, its own *growth determinants*. In sum, convergence and growth will depend on the level of human capital, the features of a country's policy framework, the rate of growth of the labor force (or "fertility" rates, see Box 2 for a discussion on this data), and the investment level on physical capital. In particular, to thoroughly examine how these factors affect convergence and growth for a given country, it is important to analyze how they compare with those of other countries. For example, in our case, the "EU average country" is a reasonable baseline. We assume the "EU average country" is one which maintains the current EU Average growth determinant values.

Table 6: Growth Determinants for CEE Countries and Other Country Groups.

	Annual Average Growth Rates 1965-89	GNP per Capita 1994 PPP Estimates	Average Investment as % of GDP 1994-95	Human Capital 1985	1996 Modified Structural Framework (i.e., Index Z)	Average Fertility Rates 1984-89 (i.e., a + δ + n)
Fastest Growing Economies	6.2%	8058	34.3%	6.73	4.26	6.4%
Fast Growing Economies	5.4%	10038	33.6%	5.66	3.71	7.0%
EU Highest	1.8%	20270	26.5%	10.33	4.22	5.0%
EU Average	2.5%	16757	18.2%	7.70	3.82	5.3%
EU Low	4.1%	10930	13.0%	3.83	3.27	5.8%
Czech Republic	n/a	8900	25.7%	n/a	4.00	5.4%
Hungary	n/a	6080	22.0%	10.75	3.10	4.9%
Poland	n/a	5480	17.1%	8.41	2.95	5.6%
Slovakia	n/a	6450	25.8%	n/a	3.05	5.5%
Slovenia	n/a	6230	21.6%	n/a	2.65	5.3%
CEE Average	n/a	6628	22.4%	9.58	3.15	5.3%

Notes: Fastest Growing Economies includes Hong Kong, Korea, Singapore, and Taiwan. The Fast Growing Economies refers to Indonesia, Japan, Malaysia, and Thailand. The notation n/a stands for data not available. The data on human capital is from Barro and Lee (1993). No equivalent human capital data is available for Czech Republic, Slovakia, and Slovenia. We use for these countries the average from Hungary and Poland. The data on investment corresponds for all non-CEE countries to the average for 1993-94 and for all CEE countries to the average for 1994-95. The GNP per capita data for 1994 is from the 1996 World Development Report. The Index of Policy Z for CEE countries is based on the original IEF Index.

Using the econometric results discussed in Section IV, we examine how CEE countries will perform under different scenarios. More specifically, we first calculate the number of years it takes for CEE countries to reach, under different scenarios, 75 percent of the GDP per capita of the EU average country. This threshold is picked since most EU structural funds allocate resources to regions which are below it. We then perform some growth exercises and discuss how much faster the growth rate of GDP per capita for CEE countries can be relative to the EU average country, once again assuming different policy scenarios[15].

[15] The above discussion on convergence and growth paths would be incomplete if we did not highlight its three main weaknesses. First, the estimated model in this paper is based on a log-linearization of the original paths of physical and human capital. While this allows to obtain closed form solutions for the dynamics of the model out of the steady state, these dynamics are valid only in the "neighborhood" of this steady state. In practice, numerical solutions to our dynamic equations would show that the speed of convergence would decrease as a country gets closer to its own steady state rather than the constant speed of convergence φ on which we currently base our analysis. Second, while we present results for different convergence and growth exercises, we assume in each of

Before discussing in detail our results, we begin first by presenting in Table 6 the key values of *environment factors* (or *growth determinants*) for different groups of countries. These values will constitute the basis on which our convergence and growth exercises are built. Table 6 is also interesting in that it appears to show that convergence has taken place among present EU member countries. For example, the average growth rate has been very low for the richest country (1.8 percent a year) and very high for the poorest country (4.1 percent a year), with the EU average settling at approximately 2.5 percent a year. Also, the countries characterized by high rates of investment are among the best growth performers. Though the average level of education of the adult population is not very high among these countries, it is accompanied by a high index value for the "policy index" in the economy (i.e., the Index Z). Finally, it is important to highlight that the index Z of CEE countries is in many cases too low relative to the current average for the European Community. As mentioned before, we assume the EU average country is one which maintains the current EU Average growth determinant values presented in Table 6.

Years for Convergence

We discuss in this sub-section the exercises that address how many years it will take to converge to 75 percent of the EU average income per capita level for five CEE countries (i.e., Czech Republic, Hungary, Poland, Slovakia, and Slovenia) under different scenarios[16]. We use for these calculations equation [xii] of Appendix 4. This equation highlights that the convergence time frame will depend on how the growth determinants of any CEE country compare to those of the EU average country. The results are summarized in Table 7.

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them that the determinants of steady state levels remain constant, an extremely unlikely assumption. In this framework, if one were to take the discussed results at face value, it is entirely possible for an economy to be beyond its golden rule level of capital per capita (i.e., the level that allows to maximize consumption per capita), thus falling in the so-called dynamically inefficient region. Finally, the Lucas' critique would apply with full-force to these convergence and growth exercises. In presenting our results we are fully aware of these limitations. However, given the slow convergence of the poorest current EU members during the last 34 years (see Table 2), we find our results consistent with that evidence and enlightening as to the policy direction that CEE countries should follow.

[16] This sub-section builds mostly on what we could call "combination scenarios" (i.e., all growth determinants are set at levels different from those currently in place in each CEE country). By contrast, in Appendix 5 we examine the individual impact of these growth determinants.

Table 7: Years for Convergence. Combination Scenarios.

	Current Trend	CEE Mean	EU Low	EU Average	EU High	Optimal GDI=25%	Optimal GDI=30%
Czech Rep.	15	28	###	31	12	11	10
Hungary	41	46	###	50	22	20	18
Poland	###	50	###	54	24	22	20
Slovakia	41	44	###	47	20	19	17
Slovenia	91	45	###	49	21	20	18

Note: ### denotes no convergence and implies that the country never reaches 75 percent of the EU average level of income per capita (i.e., the steady state of this country is below this threshold).

Scenario Assumptions: In all scenarios the EU "average" country to which CEE countries are converging is assumed to behave as dictated by the EU Average values presented in Table 6. The column titled Current Trend assumes each CEE country maintains the same growth determinant values that it currently has. The second column assumes the growth determinants are equal to the current average for the five CEE countries being examined. The next three columns assume CEE countries behave, respectively, as determined by the EU Low, EU Average, and EU High growth determinants. Note also that the scenario based on the EU Average is equivalent to the concept of absolute convergence since both the CEE countries as well as the EU average country adopt the EU Average growth determinant values (i.e., we end up using equation [xiii] of Appendix 4). Finally, the two columns titled Optimal represent the results for an ambitious set of targets. These are (i) a "policy framework" index at the maximum of 4.7 which corresponds to the value for Hong Kong; (ii) no labor force growth, as is approximately the case for Hungary; and (iii) a level of human capital equal to the EU High. In addition, each of these two columns assumes a different investment level, respectively, 25 and 30 percent of GDP.

• *What main conclusions can be reached from the results in Table 7?*

First, CEE countries are far from being on a path of rapid convergence. For most countries convergence to the set threshold would take between 4 and 9 decades if they maintain their current growth determinants. The sole exceptions are Poland, for which convergence would never be accomplished, and the Czech Republic, which converges in about 15 years. These results are presented in the column titled Current Trend in Table 7 and may be viewed as the benchmark against which all other scenarios must be evaluated (see Table 6 and notes to Table 7 for the actual growth determinant values being assumed in each of the convergence exercises we now discuss). Notice that using the growth determinant values of the EU average country (i.e., the column titled EU Average) would worsen the performance of the Czech Republic, Hungary, and Slovakia. This is a surprising result since, even though transition economies have implemented far-reaching reforms, they still lag far behind many EU member countries in terms of the "policy framework" of the economy as well as other positive determinants for growth.

However, these three countries have high levels of investment (relative to the EU average country) that enable them to compensate for other shortcomings. By contrast, for Poland and Slovenia the number of years required to converge to the mentioned threshold will be lower if they implement policies equal to those of the EU average country[17]. Notice also that other scenarios are less promising. For example, if CEE countries were to adopt growth determinant values lower than those presently in place (e.g., those that correspond to the EU Low), then neither of the CEE countries which we discuss in this paper would converge to the set threshold.

Finally, and on a more promising note, there is still significant headroom above the growth determinants of the EU average country. In this regard, the challenge for CEE countries is to implement policies which are less intrusive than those of the EU average country, thus providing an environment supportive of the effectiveness of human capital in the production process. Also, these countries should adopt policies (both macro as well as sectoral) conducive to high investment levels. In doing so, they can significantly curtail the number of years it takes to converge to a certain target level. Human capital development is also a key area for government policy. In particular, it should stress not only higher levels of education for the future working generation, but also greater emphasis should be given to enhancing the skills of those displaced workers that have emerged as a result of the transition from central planning to market-based economies. In sum, the higher the investment level, the higher the Index Z, the lower the labor force growth rate, and the higher the human capital level, the more rapidly will convergence take place. Comprising all of the above, we present three "combination" scenarios: the EU High and two Optimal scenarios with, respectively, an investment level of 25 percent and 30 percent of GDP. These scenarios are constructed using the assumptions described in the notes to Table 7 and, as can be clearly observed, they significantly reduce the years required for convergence to take place.

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[17] Slovenia's poor performance is affected by an extremely low value of the index Z (the lowest among the five CEE countries being examined). However, this should be expected to rapidly change as the economy pursues a more ambitious reform agenda, therefore significantly affecting our convergence estimates.

• *What role does the policy framework of an economy play for economic growth?*

As shown in Table 8, the index that represents the policy framework of the economy has an important role in ensuring not only the existence of convergence to the set threshold of 75 percent of the EU average income per capita, but also the number of years in which it will take place. For example, while for Poland convergence is presently not expected to take place, a higher value of this index will allow this country to converge. Also, most other countries may see the number of years required for convergence cut in more than half if the index is sufficiently high. As described in Section III, this index represents the policy framework of the economy and covers a broad range of issues; among them a country's monetary policy, fiscal policy, degree of openness, rule of law, and degree of price system distortion. The current value of this index for most CEE countries is well below that of the EU average country, which currently stands at 3.8 points (see Table 9). The sole exception is the Czech Republic whose current average is higher than the EU Average. Also, three of the components of the index for CEE countries are well below those of the EU average country. These are the degree of openness component, the indicators of monetary and financial/banking sector policies, and the degree of distortion of the price system[18].

Table 8: Years for Convergence for Different Policy Framework Scenarios.

	Current Status		**Scenarios**					
	Index Value	Years for Convergence	3.00	3.50	4.00	4.33	4.67	5.00
Czech Rep.	4.00	15	25	18	15	13	12	11
Hungary	3.10	41	44	33	27	25	23	21
Poland	2.95	###	###	71	49	42	37	33
Slovakia	3.05	41	42	31	26	23	21	20
Slovenia	2.65	91	54	37	30	27	24	23

Note: ### denotes no convergence and implies that the country never reaches 75 percent of the EU average level of income per capita (i.e., the steady state of this country is below this threshold).

Scenario Assumptions: In all scenarios it is assumed that CEE countries maintain all their current growth determinant values except that corresponding to the index that represents the existing "policy framework" (which

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18 Somewhat surprisingly, the index value for rule of law in CEE countries is not as low (relative to the EU average) as one would be tempted to expect. It is likely that this reflects the way in which this indicator is constructed. Johnson and Sheehy emphasize both excessive regulation as well as well-defined property rights.

adopts the value that appears under the heading 'scenarios'). The EU average country is assumed to behave as determined by the current EU Average growth determinant values (see Table 6).

Table 9: Components of the Index Z.

	Degree of Openness	Fiscal Policy & Size of Government	Monetary Policy & other Financial Sector Policies	Price System Distortion	Rule of Law	**Average**
EU Average	**4.52**	**2.45**	**4.11**	**4.11**	**3.93**	**3.82**
Czech Republic	4.50	3.00	4.50	3.50	4.50	**4.00**
Hungary	3.00	2.50	3.00	3.50	3.50	**3.10**
Poland	3.00	2.75	2.00	3.50	3.50	**2.95**
Slovakia	4.00	2.25	3.00	3.00	3.00	**3.05**
Slovenia	2.00	2.75	3.50	2.50	2.50	**2.65**
CEE Average	**3.30**	**2.65**	**3.20**	**3.20**	**3.40**	**3.15**

Note: The Index of Policy Z for CEE countries is based on the original IEF Index while the EU Average is based on the Modified IEF Index.

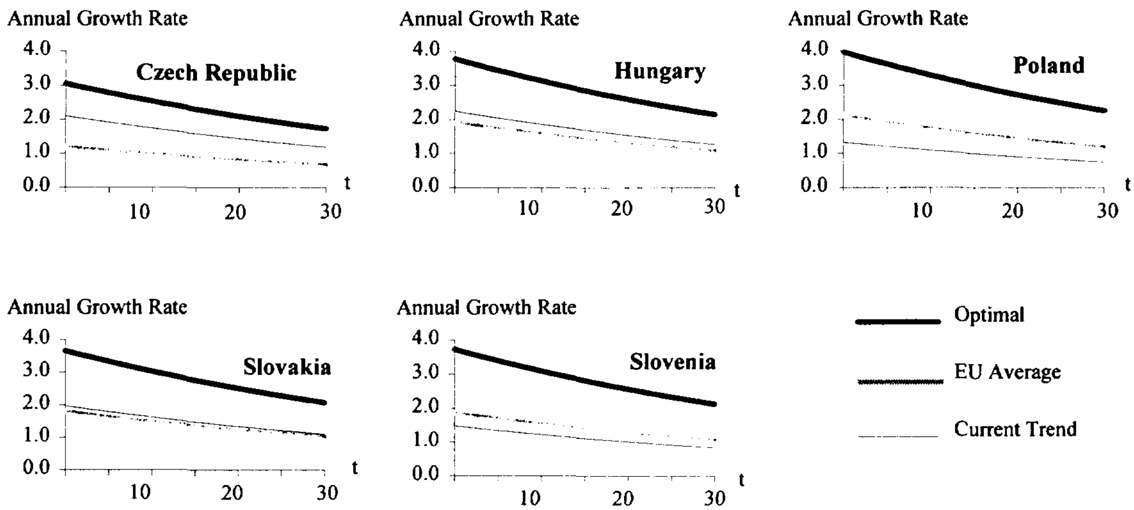
Difference in Growth Paths

The goal in this sub-section is to identify how much higher is the growth rate of GDP per capita of CEE countries vis-à-vis that of the EU average country and, in particular, the behavior of the difference in growth rates under alternative scenarios. These "differential" growth paths are calculated solving iteratively equation [xv] in Appendix 4. As before, we assume in these exercises that the EU average country maintains the current EU Average growth determinants (see Table 6)[19].

[19] Our analysis is based on differences in growth rates of per capita GDP. To obtain the growth rate of the economy we must add the growth rate of the labor force (about half a percentage point a year) and the EU growth rate of GDP per capita (say, for example, 1.5 percentage points a year). The EU growth rate of GDP per capita can be viewed as reflecting the exogenously given technological progress and the growth that results from the current growth determinants of the EU average country. Given our current coefficient estimates, the latter explains growth rates in the EU average country of about one percentage point.

Two different growth paths are presented in Figure 3; the EU Average growth path and the Optimal growth path. These paths are constructed using the growth determinants presented in Table 6 and following the assumptions described in the notes to Figure 3. Both are compared to the benchmark that results from assuming CEE countries maintain their own current growth determinant levels. We refer to this benchmark as the Current Trend.

Figure 3: Differences in Growth Paths for CEE Countries vis-à-vis the EU Average.



Scenario Assumptions: In all these growth paths we assume the European Community maintains the current EU average levels of each growth determinant (i.e., the values for the EU Average in Table 6). Thus, we need to compare how these fare relative to the growth determinant values of each CEE country. The Current Trend growth path assumes each CEE country maintains the same growth determinant values that it currently has (see Table 6 for the actual values). The growth path based on the EU Average is equivalent to the concept of absolute convergence (i.e., CEE countries have the *same* growth determinants than the EU Average and only differences in initial levels of output per capita matter). The Optimal path assumes CEE countries have (i) a "policy framework" index at the observed maximum of 4.7 which corresponds to the value of the index for Hong Kong; (ii) no labor force growth, as is approximately the case for Hungary; and (iii) a level of human capital equal to the EU High. In addition, this path assumes an investment level equal to 30 percent of GDP.

- *What main conclusions can be reached from the results in Figure 3?*

EU Average Growth Path: From the results in Figure 3 we can conclude that the Czech Republic, Hungary, and Slovakia are individually following a growth path (i.e., their own Current Trend path) which is better than the EU Average growth path (i.e., the path they would register if they adopt the growth determinants of the EU average country). Worth highlighting is the case for the Czech Republic which is significantly above the EU average country. This must be attributed to its high value for the Index Z and the high levels of investment in physical capital. By contrast, the worst performer is Poland whose Current Trend path is significantly below the EU Average growth path. However, it is important to highlight that the average level of investment in Poland for the years 1994-95 was extremely low (slightly above 17 percent of GDP), thus negatively affecting our results.

Optimal Growth Path: This path assumes CEE countries pursue (and achieve) some very ambitious goals (i.e., an investment level equal to thirty percent of GDP; a value of the index representing the policy framework of the economy of 4.7 which corresponds to the value for Hong Kong; no labor force growth, as is presently the case for Hungary; and a level of human capital equal to the EU High). In such case the growth of CEE countries is initially, on average, approximately four percentage points higher than that of the EU average country, and decreases to approximately two and one-half percentage points after 30 years. As mentioned in Table 7, in these scenarios convergence to 75 percent of the EU Average income per capita is reduced to a range between 10 and 20 years, the lowest of which corresponds to the Czech Republic and the highest represents Poland's case.

VI. Lessons for CEE Countries.

The results presented in the previous section denote both the challenge that lies ahead for CEE countries as well as the opportunity these countries have to implement policies conducive to growth. As was discussed, convergence to 75 percent of the EU average country (i.e., assuming the EU continues to perform at the present EU Average levels) will currently take, depending on the country, between 15 years and 9 decades. The sole exception is Poland which might not converge. These slow convergence estimates seem also in tune with the experience of the poorest current EU members (see Table 2) and should be attributed to the present features of some CEE countries. Among them, (i) low levels of investment; (ii) high rates of labor force growth; (iii) levels of human capital which, although relatively high, are negatively affected by the dislocations resulting from the profound transformation of these economies and have resulted in acute structural unemployment problems; and (iv) an economic policy, regulatory, and legal framework which is not as conducive to the effectiveness of inputs in the production process as it could potentially be. However, many of these growth determinants may be expected to evolve in a positive fashion in the next few years. For example, the extremely low levels of investment registered in recent years should not be the norm in the near future as the economic uncertainties that characterize stabilization periods dissipate.

• *Are there any lessons for CEE countries?*

Yes. If CEE countries implement policies conducive to enhancing the functioning of the market mechanism, then they would be able to improve upon the current bleak prospects while reaching the most promising convergence and growth results described in Table 7 and Figure 3. In particular, these countries should emphasize those aspects that stimulate economic growth; that is an environment conducive to investment and supportive of human capital development, including the policy framework in which this type of capital operates.

• *What does the experience of successful countries (i.e., those that register high per capita growth rates) show?*

First, in order to stimulate the investment decisions of private economic agents there is a need to provide a macro framework where price stability is a key goal (see, for example, Thomas and Leipziger, 1995). Thus, it is in these countries' own interest to ensure that monetary policy and fiscal policy are conducive to this stability. Also, and to avoid unexpected imbalances with potentially far-reaching implications, the sectoral policies must support the long-run sustainability of a country's macro framework by providing the appropriate economic fundamentals. For example, price stability may not be guaranteed if the financial sector in CEE countries is not transformed so as to reduce the cost of credit while enhancing the banking regulation and supervision capabilities of monetary authorities. Second, government policy also has a role in providing infrastructure and an environment conducive to human capital development. However, these should aim at enhancing the development opportunities of the private sector since, otherwise, they are prone to be abused. Finally, and encompassing all of the above, the policy framework should aim at enhancing the effectiveness of inputs in the production process. For example, the quality of human capital is in our view essential for economic growth, but must also be accompanied by the appropriate policy, regulatory, and legal framework. In particular, as shown through the empirical results in this paper, monetary and fiscal policy, the rule of law, the reliance on the price system as an allocation mechanism, and the openness to trade are all key determinants of economic growth.

In sum, given that CEE countries are well endowed with natural resources and high levels of human capital, they face a unique opportunity to complement these "fixed" environments with growth enhancing "variable" environments (i.e., what we have referred to as growth determinants). They, however, still face serious policy deficiencies and, though the transformation process has been steadfastly and courageously implemented --particularly when evaluated relative to the challenges these economies faced in the early 1990s--, the remaining reform agenda is still an enormous task to be tackled and accomplished. Those countries that drag their feet in the implementation of the pending reform agenda (i.e., financial sector reform, pension reform, and other sectoral deficiencies) will only compromise their growth prospects and curtail the potential net benefits that may be derived from the EU accession process. In this respect, our paper arrives to conclusions similar to those in other empirical growth equation models, such as Barro (1991) and Sachs and Warner (1996). Its theoretical foundation allows a more rigorous interpretation by linking the effectiveness of human capital in the production process to the overall policy framework in which this capital operates. At the same time, it serves to tie the performance of countries to their different steady state levels and, in particular, to examine the role of public policy in determining those differences.

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APPENDIX 1: Derivation of the Growth Equation.

The model represented by equation [1] through [3] in the main body of this paper can be rewritten in its intensive form (i.e., in per capita terms) as

$$y = k^{\alpha} h^{\beta} \qquad [i]$$

$$\dot{k} = s_k y - (\partial + n + a) k \qquad [ii]$$

and

$$\dot{h} = s_h y - (\partial + n + a) h \qquad [iii]$$

where y, h, and k are output, human capital, and physical capital expressed in effective labor units (i.e., the number of units per person scaled by the economy's technology level). We define n as the rate of growth of the labor force and a as the exogenously given rate of technological progress. The growth rate of GDP in effective labor units may be written as

$$\frac{\dot{y}}{y} = \alpha \frac{\dot{k}}{k} + \beta \frac{\dot{h}}{h} \qquad [iv]$$

which can be expressed using equation [ii] and equation [iii] as

$$\frac{d \ln y}{dt} = \alpha \left[s_k \; e^{(\alpha-1) \ln k} \; e^{\beta \ln h} - (a+n+\partial)\right] + \beta \left[s_h \; e^{\alpha \ln k} \; e^{(\beta-1) \ln h} - (a+n+\partial)\right] . \qquad [v]$$

A log-linearization of the above dynamic system in the neighborhood of the steady state allows to specify the growth rate of the economy (in effective labor units) as represented by

$$\frac{d \ln y}{dt} = \left[\alpha (\alpha-1) \; s_k \; k^{\alpha-1} \; h^{\beta} + \alpha \beta \; s_h \; k^{\alpha} \; h^{\beta-1}\right](\ln k - \ln k^*)$$

$$+ \left[\alpha \beta \; s_k \; k^{\alpha-1} \; h^{\beta} + \beta (\beta-1) \; s_h \; k^{\alpha} \; h^{\beta-1}\right](\ln h - \ln h^*)$$

where the * denotes the steady state values. Solving for the steady state in equations [ii] and [iii], the above equation may be rewritten as

$$\frac{d \ln y}{dt} = - (1-\alpha-\beta)(a + n + \partial)(\alpha \ln k - \alpha \ln k^* + \beta \ln h - \beta \ln h^*)$$

or

$$\frac{d \ln y}{dt} = - (1-\alpha-\beta)(a + n + \partial) \ln\left(\frac{y}{y^*}\right).$$

Defining g = ln y, g* = ln y*, and $\varphi = (1-\alpha-\beta)(a + n + \partial)$, then we may write

$$\dot{g} = -\varphi g + \varphi g^*$$

which is a linear differential equation. This first-order differential equation has a very simple solution which, after subtracting ln y(0) and dividing both sides by the number of years t that correspond to the period being analyzed, may be written as

$$\frac{\ln y(t) - \ln y(0)}{t} = \frac{1 - e^{-\varphi t}}{t}\left[-\ln y(0) + \ln y^*\right] . \qquad [vi]$$

The above equation specifies the growth rate of GDP per effective labor of any country as dependent on the natural logarithm of both the initial level of GDP per effective labor as well as the steady state level of GDP per effective labor (i.e., respectively, ln y(0) and ln y*). In sum, the farther away the economy is from its own steady state level the higher is the growth rate, with φ being the convergence coefficient.

The question that remains to be answered is what determines the steady state level of GDP per effective labor (i.e., y*). We know the steady state values are given by

$$k^* = \left[\frac{s_k^{1-\beta}\, s_h^{\beta}}{a+n+\partial}\right]^{\frac{1}{1-\alpha-\beta}} \quad \text{and} \quad h^* = \left[\frac{s_k^{\alpha}\, s_h^{1-\alpha}}{a+n+\partial}\right]^{\frac{1}{1-\alpha-\beta}} .$$

Since $y^* = k^{*\alpha}\, h^{*\beta}$, then we can define the natural log of the steady state value of output as

$$\ln y^* = \frac{-(\alpha+\beta)}{1-\alpha-\beta}\ln(\partial + n + a) + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h . \qquad [vii]$$

Using equation [vi], equation [vii], and our proxy for investment in human capital (i.e., equation [4] in the main body of this paper), the model estimated may be written as

$$\frac{\ln y(t) - \ln y(0)}{t} = \frac{1 - e^{-\varphi t}}{t}\left[-\ln y(0) + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln h + \frac{\beta\phi}{1-\alpha-\beta}\ln Z - \frac{(\alpha+\beta)}{1-\alpha-\beta}\ln(\partial + n + a)\right] + \tau + \varepsilon$$

where τ is a constant and ε is the residual assumed to have a normal distribution with mean zero and constant variance. Since y=Y/(A N) is the output per effective labor units, we may rewrite the above equation as

$$\frac{\ln \hat{y}(t) - \ln \hat{y}(0)}{t} = \frac{1}{t}\ln\left(\frac{A(t)}{A(0)}\right) + \frac{1 - e^{-\varphi t}}{t}\left[-\ln y(0) + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln h + \frac{\beta\phi}{1-\alpha-\beta}\ln Z - \frac{(\alpha+\beta)}{1-\alpha-\beta}\ln(\partial + n + a)\right] + \tau + \varepsilon \qquad [viii]$$

where $\hat{y} = Y / N$ is GDP per capita. Notice that

$$\left[\frac{1}{t} \ln\left(\frac{A(t)}{A(0)}\right)\right] = a$$

since $A(t) = A(0)\, e^{at}$. Thus, equation [viii] may be rewritten as

$$\frac{\ln \hat{y}(t) - \ln \hat{y}(0)}{t} = \chi_0 + \chi_1 \ln y(0) + \chi_2 \ln s_k + \chi_3 \ln h + \chi_4 \ln Z + \chi_5 \ln(\partial + n + a) + \varepsilon . \quad [ix]$$

The constant term χ_0 includes the exogenously given technological progress growth rate --common to all countries-- and the term with the proportionality factor γ. Also, $\hat{y}(0)$ is equal to y(0) by assuming that the initial technology level A(0) is the same for each country and normalizing it to one. Alternatively, each country could be thought to have a common level of initial technology plus a country specific random shock (e.g., due to differences in geographical locations and natural resource endowments). Thus, we normalize the common level to one and incorporate the country specific shock into the residual (i.e., we replace ε in equation [ix] for ε', which is also assumed to be normally distributed with mean zero and constant variance).

APPENDIX 2: Estimation.

This appendix starts by discussing three main econometric problems that arise in most estimations of economic growth equations. Following this discussion we present our estimation results, both those that use the Original IEF Index as well as those which are based in the Modified IEF Index.

Econometric Problems

Estimation of economic growth equations with cross-section data might be affected by the non-compliance of some key OLS assumptions of which three are worth discussing. First, some of the regressors are highly correlated, a usual problem with economic data. Thus, there is the risk that our coefficient estimates become unstable and imprecise. The same holds for the standard errors of the estimates. However, it is important to highlight that the potential multicollinearity of right hand side variables seems not to affect the statistical or economic significance of the coefficient estimates. In fact, though the initial level of GDP per capita has a partial correlation slightly above 0.7 with both investment as well as human capital, the addition of these variables improves the overall fit of the regression and the statistical significance of the coefficient estimates. Also, a test is conducted regarding the redundancy of the index Z in our regressions. The null hypothesis that the coefficient of this regressor is equal to zero (i.e., $\chi_4 = 0$) is rejected in all cases. The use of one sole index comprising different policy indicators eliminates the potential risk of multicollinearity which could exist if we used different regressors for each individual policy indicator.

Second, since the cross-section data presented relates countries with small GDP per capita levels with those that have large levels, there is a risk that the variance of the residuals denotes the presence of heteroskedasticity. However, the White test for heteroskedasticity was conducted and the null hypotheses of constant variance in the residuals was accepted. Although the key coefficient estimates do not vary significantly when Guyana and Zambia are excluded from the estimation, it does lead to the rejection of our test for constant variance of residuals. Future research will exclude these countries from the estimation and deal with its econometric implications.

Third, the national accounts data being used might present serious measurement errors. In particular, the data on initial GDP level might be reflecting a temporary trough in the level of economic activity. As a result, the presence of convergence might be overestimated and reflect cyclical components. Nonetheless, as Barro discusses (1991), these business-cycle fluctuations affect, over long periods, only in negligible amounts the computed annual average growth rates. It could also be the case that the regressors are not independent of the errors, thus violating a key assumption of OLS estimation and resulting in biased and inconsistent coefficient estimates. To control for these two possibilities, a two-stage least squares (TSLS) estimation is performed using as instrumental variable --besides all other regressors which act as their own instruments-- a lagged initial level of GDP per capita (i.e., the value corresponding to 1960).

Estimation Using the Original IEF Index

The estimation of equation [ix] of this appendix section using the original IEF index leads to the results presented in Table A-1. Four regression results are reported. The first corresponds to an ordinary least squares estimation. Note that equation [viii] highlights that some of the estimated coefficients should conform with the restriction that

$$\chi_2 + \chi_3 = -\chi_5 . \qquad [x]$$

A Wald test of the above restriction is conducted and the null hypothesis accepted.

Table A-1: Estimation Using the IEF Index.

Dependent Variable: Annual Growth Rate of per Capital GDP in the Period 1965-1989.

Regression:	1		2		3		4	
Estimation Method:	OLS		Restricted OLS		TSLS		Restricted TSLS	
Sample Size:	85		85		84		84	
Constant	0.0583		0.0790		0.0698		0.0875	
	(0.036)		(0.018)		(0.037)		(0.019)	
ln y(0)	-0.0176		-0.0173		-0.0187		-0.0184	
	(0.003)		(0.003)		(0.003)		(0.003)	
ln (I/GDP)	0.0147		0.0148		0.0169		0.0171	
	(0.004)		(0.004)		(0.004)		(0.004)	
ln h	0.0086		0.0093		0.0086		0.0091	
	(0.004)		(0.004)		(0.004)		(0.004)	
ln Z	0.0239		0.0243		0.0236		0.0238	
	(0.009)		(0.009)		(0.009)		(0.009)	
ln ($a+\delta+n$)	-0.0334		-		-0.0339		-	
	(0.014)		-		(0.015)		-	
Adjusted. R Squared	0.483		0.487		0.477		0.481	
	(0.014)		(0.014)		(0.014)		(0.014)	
Tests (F statistics reported):								
Regression Not Significant	16.71	Reject	20.92	Reject	16.52	Reject	20.78	Reject
Restriction [14] is True	0.446	Accept	-		0.305	Accept	-	
Z is Redundant	7.278	Reject	-		7.035	Reject	-	
Implied Values of:								
φ	0.0229		0.0231		0.0248		0.0244	
α	-		0.358		-		0.383	
β	-		0.225		-		0.204	
ϕ	-		2.604		-		2.608	

Note: *Reported between parentheses are the standard errors.*

The second regression incorporates the restriction described by [x]. Thus, we estimate

$$\frac{\ln \hat{y}(t) - \ln \hat{y}(0)}{t} = \chi_0 + \chi_1 \ln y(0) + \chi_2 \ln s_k + \chi_3 \ln h + \chi_4 \ln Z - (\chi_2 + \chi_3) \ln(\partial + n + a) + \varepsilon . \qquad [xi]$$

The regression coefficients are non-linear functions of the parameters in the growth equation. Thus, from equation [ix] and the restricted equation [xi] we can estimate the implied values of φ, α, β, and ϕ, of which the second and the third constitute production function parameters. These implied values are also reported in Table A-1.

The third regression is the equivalent of the first except that we use the mentioned two-stage least square (TSLS) estimation. As mentioned before, the lagged value of the initial level of GDP per capita, as well as the original values of all other regressors, are the instrumental variables. The results are tested for the compliance with restriction [x] which is accepted. This motivates estimating our fourth and last regression in this group following the restricted specification in equation [xi]. As before, the implied values of φ, α, β, and ϕ are calculated and reported in the above-mentioned table.

Estimation Using the Modified IEF Index

As a minor modification, we change the IEF index by proposing a different interpretation on the degree of openness of an economy. With respect to trade, we concentrate not only on the tariff level, but also on the presence of quantitative restrictions. As to capital flows, we center the definition of a country's openness to capital movements on the presence of exchange rate distortions. The latter is measured by the premium that may exist between the market and the official exchange rates.

Our measure of openness of an economy has the added advantage of containing time series information since it is based on average data for the 1970s and 1980s. The modification to this component of the IEF index is thoroughly explained in Box 3 in the main body of this paper and implies a change to 20 percent of the index. A regression with the openness to trade component in the original IEF as the dependent variable against a constant and the openness component we construct has an R square close to 0.27 or, for that matter, a correlation coefficient between both "openness" indexes of 0.52. Thus, this component of the IEF index can be judged to have changed substantially due to the construction methodology we propose.

Based on this modification we run a second set of four regressions. The first regression estimates equation [ix]. Once again, since a Wald test accepts the null hypothesis presented in equation [x], we run a second regression directly imposing this restriction into the estimation (i.e., we estimate equation [xi]) and use these results to calculate the implied values of φ, α, β, and ϕ. The last two of the regressions estimated follow the exact same steps except that we use a two-stage least square estimation with the instrumental variables previously discussed. The results of these regressions are presented in Table A-2.

Table A-2: Estimation Using the Modified IEF Index.

Dependent Variable: Annual Growth Rate of per Capital GDP in the Period 1965-1989.

Regression:	1	2	3	4
Estimation Method:	OLS	Restricted OLS	TSLS	Restricted TSLS
Sample Size:	84	84	83	83
Constant	0.0700	0.0797	0.0811	0.0879
	(0.036)	(0.018)	(0.037)	(0.019)
ln y(0)	-0.0179	-0.0178	-0.0191	-0.0189
	(0.003)	(0.003)	(0.003)	(0.003)
ln (I/GDP)	0.0149	0.0149	0.0169	0.0169

	(0.004)		(0.004)		(0.004)		(0.004)	
ln h	0.0095		0.0099		0.0095		0.0098	
	(0.004)		(0.004)		(0.004)		(0.004)	
ln (Modified Z)	0.0251		0.0255		0.0248		0.0250	
	(0.009)		(0.008)		(0.009)		(0.008)	
ln (a+δ+n)	-0.0292		-		-0.0297		-	
	(0.015)		-		(0.015)		-	
Adjusted R Squared	0.492		0.498		0.485		0.491	
	(0.014)		(0.014)		(0.014)		(0.014)	
Tests (F statistics reported):								
Regression Not Significant	17.07	Reject	21.56	Reject	16.87	Reject	21.34	Reject
Restriction [14] is True	0.097	Accept	-		0.045	Accept	-	
Z is Redundant	8.719	Reject	-		8.459	Reject	-	
Implied Values of:								
φ	0.0235		0.0232		0.0255		0.0253	
α	-		0.350		-		0.372	
β	-		0.232		-		0.214	
ϕ	-		2.582		-		2.566	

Note: Reported between parentheses are the standard errors.

APPENDIX 3: List of Countries Used in Each Estimation and Corresponding Data.

	Country	GDP per Capita 1960	GDP per Capita 1965	Average Annual Growth 1965-89	Investment as a Share of GDP	IEF Index	Modified IEF Index	Human Capital	Labor Force Growth (a + δ + n)	Observation in regression? Notes: y = yes, Blank Cell = no Group 1				Group 2			
										1	2	3	4	1	2	3	4
1	South Korea	1143	1336	7.0	21.0	3.7	3.6	6.9	7.1	y	y	y	y	y	y	y	y
2	Singapore	2115	2340	7.0	29.2	4.7	4.7	4.1	7.1	y	y	y	y	y	y	y	y
3	Malta	1683	1770	6.0	23.1	3.0	3.1	6.4	5.5	y	y	y	y	y	y	y	y
4	Taiwan	1626	2105	6.0	21.3	4.1	4.0	6.1	7.5	y	y	y	y	y	y	y	y
5	Botswana	702	763	5.6	16.2	3.2	3.3	2.6	8.2	y	y	y	y	y	y	y	y
6	Hong Kong	2825	4330	5.5	19.8	4.8	4.7	6.6	7.4	y	y	y	y	y	y	y	y
7	Romania	500	682	5.1	28.1	2.3	-	-	5.9								
8	Japan	3479	5189	4.5	33.9	4.0	4.1	8.0	6.1	y	y	y	y	y	y	y	y
9	Indonesia	798	765	4.5	14.1	3.2	3.0	3.2	7.2	y	y	y	y	y	y	y	y
10	Cyprus	2494	3268	4.3	27.1	3.4	3.3	7.2	5.9	y	y	y	y	y	y	y	y
11	Portugal	2188	2811	4.1	22.7	3.4	3.3	3.0	5.4	y	y	y	y	y	y	y	y
12	Thailand	1221	1470	4.1	16.9	3.7	3.8	4.2	7.8	y	y	y	y	y	y	y	y
13	Malaysia	1831	2156	4.1	22.1	3.6	3.9	4.6	7.8	y	y	y	y	y	y	y	y
14	Lesotho	393	515	3.9	8.7	2.4	2.4	3.2	7.3	y	y	y	y	y	y	y	y
15	USSR	2830	3579	3.8	38.4	2.5	-	-	6.1								
16	Barbados	3293	4033	3.2	12.2	3.0	3.2	7.5	5.6	y	y	y	y	y	y	y	y
17	Brazil	2281	2382	3.2	19.2	2.6	2.6	3.1	7.6	y	y	y	y	y	y	y	y
18	Congo	1412	1367	3.2	9.5	2.2	2.6	-	7.8								
19	China	704	718	3.2	19.8	2.2	2.1	-	7.0								
20	Tunisia	1406	1593	3.2	14.3	3.4	3.1	1.9	7.3	y	y	y	y	y	y	y	y
21	Greece	2414	3519	3.2	24.5	3.2	3.2	6.4	5.8	y	y	y	y	y	y	y	y
22	Ireland	3918	4737	3.1	24.4	3.8	3.8	7.5	5.8	y	y	y	y	y	y	y	y
23	Finland	6239	7545	3.1	34.7	3.7	3.8	9.3	5.6	y	y	y	y	y	y	y	y
24	Italy	5214	6490	3.0	27.8	3.3	3.4	5.8	5.6	y	y	y	y	y	y	y	y

25	Cameroon	804	847	3.0	7.9	2.4	2.6	1.7	7.5	y	y	y	y	y	y	y	y
26	Norway	6443	7950	3.0	31.2	3.6	3.7	10.3	5.7	y	y	y	y	y	y	y	y
27	Spain	3620	5315	2.8	25.0	3.3	3.3	5.0	5.9	y	y	y	y	y	y	y	y
28	Austria	5783	6953	2.8	25.6	4.0	4.0	6.3	5.4	y	y	y	y	y	y	y	y
29	Canada	8720	10299	2.7	23.7	4.0	4.2	10.0	6.5	y	y	y	y	y	y	y	y
30	Jordan	1494	2072	2.7	13.3	3.2	3.2	3.3	7.1	y	y	y	y	y	y	y	y
31	Israel	4240	5613	2.6	25.6	3.1	2.6	8.9	7.8	y	y	y	y	y	y	y	y
32	Syria	2025	2621	2.6	14.6	1.8	1.8	3.1	8.2	y	y	y	y	y	y	y	y
33	Belgium	6228	7650	2.5	23.5	3.9	3.9	8.8	5.4	y	y	y	y	y	y	y	y
34	Egypt	1027	1295	2.5	4.4	2.6	2.6	-	7.4								
35	France	6707	8376	2.5	27.1	3.7	3.9	5.9	5.8	y	y	y	y	y	y	y	y
36	Turkey	2043	2282	2.5	20.9	3.0	2.6	2.7	7.5	y	y	y	y	y	y	y	y
37	Dominican Rep.	1561	1667	2.5	14.3	2.6	2.5	3.7	7.7	y	y	y	y	y	y	y	y
38	Algeria	2207	2057	2.4	20.3	2.8	2.9	1.8	7.8	y	y	y	y	y	y	y	y
39	Colombia	2191	2356	2.2	15.8	3.0	2.8	4.2	7.6	y	y	y	y	y	y	y	y
40	Ecuador	1882	2056	2.2	22.0	2.9	2.5	5.0	7.9	y	y	y	y	y	y	y	y
41	Morocco	1050	1589	2.2	8.7	3.3	3.2	-	7.6								
42	Germany	7355	8902	2.2	27.8	3.9	3.9	8.4	5.6	y	y	y	y	y	y	y	y
43	United Kingdom	7721	8713	2.2	18.0	4.1	4.1	8.4	5.4	y	y	y	y	y	y	y	y
44	Fiji	2772	2798	2.1	17.3	2.9	-	6.0	7.3	y	y	y	y				
45	Sri Lanka	1594	1491	2.1	8.4	3.4	3.3	5.2	7.0	y	y	y	y	y	y	y	y
46	Australia	9160	10348	2.0	28.7	3.9	4.0	10.1	6.8	y	y	y	y	y	y	y	y
47	Netherlands	7149	8629	2.0	24.5	4.2	4.1	8.2	6.1	y	y	y	y	y	y	y	y
48	Mexico	3675	4355	1.9	16.4	2.7	2.6	3.8	7.7	y	y	y	y	y	y	y	y
49	India	956	940	1.9	13.6	2.3	2.1	2.7	7.3	y	y	y	y	y	y	y	y
50	Denmark	7737	9598	1.9	25.6	4.1	4.0	10.1	5.5	y	y	y	y	y	y	y	y
51	Pakistan	817	1148	1.8	10.5	3.0	2.9	1.8	8.0	y	y	y	y	y	y	y	y
52	Nigeria	734	811	1.8	11.7	2.8	2.7	-	7.0								
53	Paraguay	1528	1655	1.8	12.3	3.4	3.0	4.5	7.9	y	y	y	y	y	y	y	y
54	Sweden	8530	10528	1.8	23.3	3.5	3.3	8.9	5.5	y	y	y	y	y	y	y	y
55	Swaziland	1591	2182	1.7	12.6	3.1	3.2	3.3	8.1	y	y	y	y	y	y	y	y
56	Kenya	876	821	1.7	15.2	3.0	2.9	2.3	9.0	y	y	y	y	y	y	y	y
57	United States	11713	13670	1.7	21.5	4.1	4.1	11.5	6.3	y	y	y	y	y	y	y	y
58	Myanmar	399	522	1.5	8.3	1.7	1.6	1.5	7.3	y	y	y	y	y	y	y	y
59	Switzerland	10670	12633	1.4	29.1	4.2	4.2	8.3	5.9	y	y	y	y	y	y	y	y
60	Burkina Faso	576	474	1.4	6.8	2.3	2.2	-	7.4								
61	Philippines	1481	1616	1.2	14.9	3.1	3.2	6.0	7.8	y	y	y	y	y	y	y	y
62	Costa Rica	2748	3208	1.1	15.8	3.2	2.9	4.9	8.1	y	y	y	y	y	y	y	y
63	Panama	2014	2579	1.1	19.2	3.6	3.9	5.8	7.7	y	y	y	y	y	y	y	y
64	Mali	683	559	1.1	5.9	2.9	3.0	0.6	7.3	y	y	y	y	y	y	y	y
65	South Africa	2740	3289	1.0	18.4	3.0	3.1	4.7	7.5	y	y	y	y	y	y	y	y
66	Malawi	493	537	1.0	9.2	2.6	2.5	2.3	7.9	y	y	y	y	y	y	y	y
67	Honduras	1346	1462	1.0	13.6	2.9	2.8	2.8	8.2	y	y	y	y	y	y	y	y
68	Chile	3593	4055	1.0	19.0	3.6	3.3	6.0	7.0	y	y	y	y	y	y	y	y
69	Zimbabwe	1281	1229	0.9	16.4	2.3	2.2	2.4	8.3	y	y	y	y	y	y	y	y
70	Uruguay	4609	4297	0.9	12.3	3.2	3.1	6.0	5.7	y	y	y	y	y	y	y	y
71	Bolivia	1461	1715	0.9	14.5	3.3	3.0	4.0	7.4	y	y	y	y	y	y	y	y
72	New Zealand	9527	10773	0.9	24.4	4.3	4.1	11.8	6.4	y	y	y	y	y	y	y	y
73	Bangladesh	1197	1446	0.8	3.9	2.4	2.1	1.6	7.4	y	y	y	y	y	y	y	y
74	Guatemala	2156	2312	0.7	9.0	3.2	3.1	2.3	7.9	y	y	y	y	y	y	y	y
75	Saudi Arabia	4957	7676	0.6	5.3	3.1	-	-	9.3								
76	Trinidad & Tob.	7172	8165	0.6	12.1	3.5	3.2	6.1	6.8	y	y	y	y	y	y	y	y
77	Jamaica	2238	2701	0.5	20.7	3.3	3.2	3.7	6.4	y	y	y	y	y	y	y	y
78	El Salvador	1842	2253	0.1	8.2	3.6	3.5	3.2	7.4	y	y	y	y	y	y	y	y
79	Senegal	1332	1455	0.0	5.0	2.6	2.8	2.1	7.5	y	y	y	y	y	y	y	y
80	Surinam	2603	2988	0.0	16.0	2.1	-	-	6.7								
81	Argentina	5273	5906	-0.1	16.5	3.4	3.2	6.4	6.5	y	y	y	y	y	y	y	y
82	Ivory Coast	1407	1770	-0.1	10.7	2.8	-	-	8.7								
83	Haiti	1161	1130	-0.2	4.5	1.8	2.1	1.4	6.7	y	y	y	y	y	y	y	y
84	Ghana	1150	1142	-0.3	5.8	2.8	2.7	2.6	7.5	y	y	y	y	y	y	y	y
85	Mauritania	997	1133	-0.3	13.9	2.2	2.1	-	7.3								
86	Iran	3853	4387	-0.3	14.3	1.3	1.4	2.5	8.5	y	y	y	y	y	y	y	y
87	Papua New G.	1548	2143	-0.4	14.8	2.9	3.3	1.2	7.3	y	y	y	y	y	y	y	y

88	Peru	2576	3200	-0.6	17.4	3.0	2.8	5.2	7.7	y	y	y	y	y	y	y	y
89	Sierra Leone	-	1396	-0.8	1.4	2.3	2.4	1.6	6.9	y	y			y	y		
90	Somalia	1391	1214	-0.8	8.0	1.3	1.4	-	8.7								
91	Niger	673	814	-0.9	7.9	2.3	2.7	0.5	7.7	y	y	y	y	y	y	y	y
92	Benin	1381	1510	-0.9	6.0	3.1	3.2	0.6	7.6	y	y	y	y	y	y	y	y
93	Zaire	627	705	-1.1	3.7	1.8	1.8	1.8	7.8	y	y	y	y	y	y	y	y
94	Venezuela	8236	9747	-1.2	17.5	2.5	2.6	4.7	8.4	y	y	y	y	y	y	y	y
95	Zambia	1246	1438	-1.5	19.0	3.1	2.9	3.5	8.1	y	y	y	y	y	y	y	y
96	Angola	1178	1346	-1.7	3.4	1.7	1.9	-	7.3								
97	Guyana	2106	2073	-1.8	23.3	2.6	2.7	4.7	6.6	y	y	y	y	y	y	y	y
98	Mozambique	1448	1597	-1.9	1.8	2.0	2.2	0.9	7.4	y	y	y	y	y	y	y	y
99	Madagascar	1499	1401	-2.0	1.3	2.7	3.1	-	7.5								
100	Nicaragua	2112	2957	-2.3	11.7	2.4	2.2	3.0	7.9	y	y	y	y	y	y	y	y

APPENDIX 4: Equations Used in the Convergence and Growth Calculations.

We derive in this appendix the equations used in our growth and convergence exercises. Note that all calculations presented in the main body of this paper assume that the growth determinants of the European Community are those that correspond to the current EU average country.

Years for Convergence

Defining $L = a + n + \delta$, the restricted equation [xi] can be rewritten for country i as

$$\frac{\ln \hat{y}_i(t)}{t} = \chi_0 + \left(\frac{1}{t} + \chi_1\right) \ln y_i(0) + \chi_2 \ln s_k^i + \chi_3 \ln h_i + \chi_4 \ln Z_i - (\chi_2 + \chi_3) \ln L_i .$$

Writing the same equation for country j, subtracting one from the other, and using the fact that

$$\chi_1 = -\left(\frac{1 - e^{-\varphi t}}{t}\right),$$

then we can write

$$\ln \hat{y}_i(t) - \ln \hat{y}_j(t) = e^{-\varphi t} \left(\ln y_i(0) - \ln y_j(0)\right) + \left(1 - e^{-\varphi t}\right) \left[\frac{\alpha}{1-\alpha-\beta} \left(\ln s_k^i - \ln s_k^j\right)\right.$$

$$\left. + \frac{\beta}{1-\alpha-\beta} \left(\ln h_i - \ln h_j\right) + \frac{\beta \phi}{1-\alpha-\beta} \left(\ln Z_i - \ln Z_j\right) - \frac{\alpha+\beta}{1-\alpha-\beta} \left(\ln L_i - \ln L_j\right)\right] . \qquad \text{[xii]}$$

Thus, the difference in output levels between country i and country j may be interpreted as the weighted average of the initial difference in GDP per capita and the initial difference in steady state values; the latter determined by differences in investment, human capital, labor force growth, and policy frameworks (i.e., the term between square brackets in the above equation).

If country i and j have the same steady state, then the above equation reduces to

$$\ln\left(\frac{\hat{y}_i(t)}{\hat{y}_j(t)}\right) = e^{-\varphi t} \ln\left(\frac{y_i(0)}{y_j(0)}\right). \qquad [xiii]$$

Since the initial value of GDP is known for each country, then setting a target for the left hand side of the equation allows to solve for the number of years t required to achieve it. For example, assume i is the poorest of the two countries. Let

$$y_i(0) = \frac{1}{4}\, y_j(0)$$

and set the target for time t at

$$\hat{y}_i(t) = \frac{3}{4}\, \hat{y}_j(t)\ . \qquad [xiv]$$

Replacing into equation [xiii] and using the value of φ that has been estimated (i.e., approximately 0.0248), we can conclude that a country which initially has a GDP per capita equal to one fourth of that of another will take 63 years to reach the target set in equation [xiv]. Equation [xiii] may also be used to calculate the years it would take for CEE countries to converge to a certain income per capita target when we assume countries have different steady state levels. This is the type of convergence exercise we discuss in Section V of this paper.

Differential Growth Rates

Rewriting equation [xi] for country i and country j and subtracting one from the other we have

$$\left(\frac{\ln \hat{y}_i(t) - \ln \hat{y}_i(0)}{t}\right) - \left(\frac{\ln \hat{y}_j(t) - \ln \hat{y}_j(0)}{t}\right) = \chi_1 \left(\ln y_i(0) - \ln y_j(0)\right)$$

$$+\chi_2 \left(\ln s_k^i - \ln s_k^j\right) + \chi_3 \left(\ln h_i - \ln h_j\right) + \chi_4 \left(\ln Z_i - \ln Z_j\right) - \left(\chi_2 + \chi_3\right) \left(\ln L_i - \ln L_j\right) \qquad [xv]$$

which is the difference in the per capita growth rates between country i and country j. Assuming country j adopts the values that correspond to the EU average country, we can then determine how much higher or lower is the per capita growth rate of CEE countries by solving iteratively equation [xv]. If we are interested in the total real growth rate of the economy, then we should add to what is determined by the above equation the growth rate of the labor force (say, on average, half a percentage point a year) and the growth registered by country j (e.g., 1.5 percentage points a year). The growth of country j can be assumed to be the result of exogenous technological progress.

APPENDIX 5: Individual Convergence Scenarios.

The convergence exercises in Table A-3 assume that all except one of the growth determinants remain at each country's current levels (see Table 6 for information on these levels). This table allows to examine the implications of each growth determinant for a country's convergence prospects. Take for example the case of Poland. The value of the index that represents the policy framework is crucial in determining if this country will or will not converge. For other countries, convergence might be cut in more than half depending on the existing policy framework on which they operate. Another factor crucial in determining the years required for convergence is the rate of growth of the labor force, though it is less clear which policies the governments of CEE countries could pursue in this regard to strengthen a country's growth performance. However, one should expect countries with high "fertility" rates (i.e., including the depreciation rate and the rate of technological progress) and low levels of human capital to be among the worst performers.

In other cases convergence requires important improvements from the current levels of investment. Once again, the most notable case is that of Poland. However, its poor prospect derives from a combination of factors; particularly low investment levels and low value of the index representing the policy framework, and is also worsened by a high rate of growth of the labor force and the fact that this country is notably below the other CEE countries in terms of initial GDP per capita (see Table 6). In sum, the higher the investment level, the higher the Index Z (i.e., policy framework), the lower the labor force growth rate, and the higher the human capital level, the more rapidly will convergence take place.

Table A-3: Years for Convergence. Individual Scenarios.

Investment Scenarios (as a percentage of GDP).

	CEE Mean	17.5	20.0	22.5	25.0	27.5	30.0
Czech Rep.	17	24	20	17	15	14	13
Hungary	40	61	47	40	35	31	29
Poland	68	###	96	67	55	47	42
Slovakia	52	133	68	52	43	37	33
Slovenia	78	###	168	77	58	48	42

Human Capital Scenarios (average years of education).

	CEE Mean	7	8	9	10	11	12
Czech Rep.	15	18	16	15	14	14	13
Hungary	41	55	48	43	40	37	35
Poland	###	###	###	###	###	173	110
Slovakia	41	57	48	43	39	36	34
Slovenia	91	###	###	111	83	69	61

Index of Structural Framework Scenarios.

	CEE Mean	3.00	3.50	4.00	4.33	4.67	5.00
Czech Rep.	23	25	18	15	13	12	11
Hungary	40	44	33	27	25	23	21
Poland	138	###	71	49	42	37	33
Slovakia	38	42	31	26	23	21	20
Slovenia	47	54	37	30	27	24	23

Fertility Scenarios (in percent).

	CEE Mean	5.0%	5.2%	5.4%	5.6%	5.8%	6.0%
Czech Rep.	15	13	14	15	16	17	18
Hungary	49	42	46	51	57	65	75
Poland	235	90	123	###	###	###	###
Slovakia	38	33	36	39	42	47	52
Slovenia	96	67	81	107	###	###	###

Notes: ### denotes no convergence and implies that the country never reaches 75 percent of the EU average level of income per capita (i.e., the steady state of this country is below this threshold). Recall that fertility rates have from the outset a joint 5 percent level which represents the depreciation rate and the rate of exogenous technological progress (see Box 2 for a more thorough discussion of this topic).

Scenario Assumptions: In all scenarios the "average" EU country to which CEE countries are converging is assumed to behave as the EU Average values presented in Table 6. The column titled CEE Mean assumes the growth determinant values that correspond to the average of all five CEE countries. The next columns introduce variations to each of the growth determinants mentioned (i.e., clockwise, investment, human capital, index Z, and fertility rates). All other growth determinants remain at the levels that correspond to each country, the sole exception being human capital which, when fixed, is assumed to remain constant at the CEE Mean level (i.e., 9.6 years).

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